

REMARKS

The instant application discloses a method and apparatus for reducing interference between multiple, closely spaced antennas. Each antenna connects to a signal circuit via a signal path. The instant invention reduces interference between these closely spaced antennas by connecting a parallel tuning circuit in parallel with at least one signal path. Advantages of this invention include reduced power consumption, reduced antenna sizes, reduced package sizes, reduced coupling between antennas, reduced feedback in radios, better impedance matching, and reduced spurious emissions (page 5, lines 22-25).

The examiner rejected claims 1-31 under 35 U.S.C. §103(a) as being unpatentable over U.S. Patent 5,784,032 to Johnston et al. (the Johnston patent) in view of U.S. Patent 6,211,830 to Monma et al. (the Monma patent). The examiner asserts that the Johnston patent discloses a tuning circuit connected in parallel with the signal path. To support this assertion, the examiner cites column 10, lines 35-37. However, this citation ignores column 10, line 34, which cites a series component that works in cooperation with the parallel component to form the matching circuit. Therefore, the matching circuit of the Johnston patent is not a ~~matching circuit~~ connected in parallel to the signal path, as defined in the instant application. The instant invention uses a matching circuit connected in parallel to the signal path to provide impedance matching and isolation without adding insertion loss to the transmission path. Because the series component of the Johnston patent adds insertion loss, among other things, the Johnston patent does not accomplish the objectives of the instant invention. Therefore, Applicant believes that the Johnston patent does not teach a multiple antenna system comprising a tuning circuit connected in parallel to the signal path.

Even if the examiner insists that the matching circuit of the Johnston patent is a ~~parallel circuit~~ connected in parallel to the signal path, the combination of the Johnston patent with the Monma patent does not teach the instant invention. The Monma patent discloses a selective tuning circuit that selectively adjusts the impedance of a first antenna. The tuning circuits, as

well as the selection switch, are in series with the transmission line (Figures 2, 8, 9, and 12 of the Monma patent). Therefore, at least undesirable insertion loss is included in any solution that combines the Johnston patent and the Monma patent. Further, if the tuning circuit of the Monma patent, or any circuit resulting from the combination of the Monma patent with the Johnston patent, is disconnected from the transmission line, the signal circuit will also necessarily be disconnected from the antenna. In direct contrast, as recited in independent claim 1, the tuning circuit of the instant invention is "selectively connectable in parallel with the signal path." Therefore, when the instant invention selectively decouples the tuning circuit from the transmission line by opening the selection switch (see Figure 3), the resulting antenna circuit is still connected to the signal circuit. Because the combination of the Johnston patent with the Monma patent does not teach the elements of claim 1, as required by §103, claim 1 and all claims depending from claim 1 are patentable over the cited art. Applicant respectfully requests the examiner reconsider the rejection of claims 1-25.

Because independent claim 26 also recites "selectively connecting in parallel the first impedance matching circuit with a transmission line," the arguments presented above also apply to independent claim 26 and all dependent claims. Therefore, Applicant respectfully requests reconsideration for claims 26-31.

Applicant also disagrees with the rejection of claims 10, 12-16, 18, 21, and 27-29. The Johnston patent discloses multiple antenna elements, where each antenna element is isolated from the other antenna elements. This isolation is highly dependent on the size, shape, and orientation, with respect to the ground plane, of each antenna element.

The isolation between the antenna elements in the Johnston patent is independent of the tuning/matching circuits. The tuning circuits of the Johnston patent are designed to cause a resonance of the antenna at the desired operating frequency. The matching circuits transform the remaining input impedance of a particular antenna element to an impedance that matches the corresponding feed transmission line and/or transmitter and/or receiver (column 10, lines 8-

13 of the Johnston patent). Therefore, each tuning/matching circuit is designed to optimize the performance of the corresponding antenna element. The tuning/matching circuits are not designed to affect the coupling between antenna elements.

In direct contrast, the instant application discloses a first parallel tuning circuit connected in parallel with a first antenna element to prevent coupling to a second antenna, as claimed in claim 10 and 18. Alternatively, the first parallel tuning circuit may match an impedance of the second antenna, as claimed in claims 12, 13, 21, 28, and 29. Further, as claimed in claims 14-16 and 27, the second signal path may also comprise a second parallel tuning circuit connected in parallel with the second signal path that improves isolation between the first and second antennas. Neither the Johnston patent nor the Monma patent, alone or in combination, disclose or suggest these features. Therefore, Applicant asserts that dependent claims 10, 12-16, 18, and 21 are patentable over the combined cited art. Applicant respectfully requests reconsideration.

The examiner rejected claims 32-38 under U.S.C. §103(a) as being unpatentable over the Johnston patent in view of the Monma patent, and further in view of U.S. Patent 4,549,312 to Michaels et al. (the Michaels patent). The Michaels patent uses a specific interference rejection filter, independent of any impedance matching, to reject interfering narrow band received signals. In direct contrast, another application for the parallel tuning circuit of the instant application is to compensate for external interference, such as interference caused by an object near the antenna that detunes the antenna (page 8, lines 10-19). This feature is recited in claim 32 ("wherein first impedance matching circuit dynamically adjusts impedance based on external interference"). The instant invention is directed to a different type of interference than the Michaels patent, and therefore is solving a different problem. Further, the instant application "reuses" the matching circuit to address the interference problem, as opposed to adding the filter circuitry of the Michaels patent. Therefore, the combination of Johnston, Monma, and

Michaels do not disclose the invention claimed in claim 32. Applicant respectfully requests reconsideration.

The arguments presented above also apply to claims 33-38. Because the Johnston patent, alone or in combination with the Monma patent, does not disclose selectively connecting a parallel impedance circuit in parallel with a first signal path, these two patents do not support a prima facie case of obviousness over claims 33-38. Further, the Michaels patent detects the presence of undesirable narrow band signals in a received signal while the instant invention detects the operational state of a signal source by sensing the active/inactive state of each antenna (page 11, lines 1-7). These two situations are completely unrelated. Because the Michaels patent, alone or in combination with the Johnston and Monma patents, does not detect the active/inactive state of each antenna as claimed in claim 33, claim 33 and dependent claims 34-38 are patentable over the cited art. Applicant respectfully requests reconsideration.

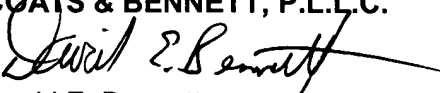
For the forgoing reasons, it is respectfully urged that the present application is in condition for allowance and notice to such effect is respectfully requested.

Attached hereto is a marked-up version of the changes made to the claims by the current amendment. The attached page is captioned **"Version with markings to show changes made."**

Respectfully submitted,

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10. (Amended) The multiple antenna system of claim 9, wherein the first parallel tuning circuit [is capable of increasing] increases the electromagnetic isolation between the first and second antennas in multiple frequency bands.

12. (Amended) The multiple antenna system of claim 11, wherein the impedance matching circuit [is capable of matching] matches an impedance of the second antenna via electromagnetic coupling with the first antenna.

13. (Amended) The multiple antenna system of claim 11, wherein the impedance matching circuit [is capable of matching] matches an impedance of the second antenna.

15. (Amended) The multiple antenna system of claim 1 further comprising:
(d) a second parallel tuning circuit selectively connectable in parallel to the second signal path.

16. (Amended) The multiple antenna system of claim 15, wherein the second parallel tuning circuit [is capable of optimizing] increases the electromagnetic isolation between the first and second antennas.

20. (Amended) The multiple antenna system of claim 19, wherein each band tuning circuit creates a different impedance at an input to the first antenna associated with the connection to the first signal circuit.

21. (Amended) The multiple antenna system of claim 19, wherein the first tuning circuit includes a first band tuning circuit [capable of tuning] having an impedance matched to the second antenna and a second band tuning circuit [capable of tuning] having an impedance matched to a third antenna.

22. (Amended) The multiple antenna system of claim 19, wherein the first parallel tuning circuit [is capable of dynamically adjusting the impedance] comprises an adjustable impedance based on selectively connecting different ones of the plurality of band tuning circuits with the first signal path.

23. (Amended) The multiple antenna system of claim 19, further comprising a detector [capable of dynamically connecting one or more of the plurality] to control selective connection of individual ones of the plurality of band tuning circuits with the first signal path.

26. (Amended) A parallel tuning circuit for use in a multiple antenna system, comprising:

(a) a first impedance matching circuit; and

(b) a first switch [capable of] selectively connecting in parallel the first impedance matching circuit[s] with a transmission line connecting a first antenna to a first signal circuit.

27. (Amended) A parallel tuning circuit of claim 26, further comprising:

(a) a second impedance matching circuit; and

(b) a second switch [capable of] selectively connecting in parallel the second impedance matching circuit[s] with a transmission line connecting a second antenna to a second signal circuit.

28. (Amended) The parallel tuning circuit of claim 26, wherein the first impedance matching circuit [is capable of matching] matches an impedance of [a] the second antenna.

29. (Amended) The parallel tuning circuit of claim 26, wherein the first impedance matching circuit [is capable of matching] matches an impedance of the second antenna in multiple frequency bands.

33. (Amended) A method of adjusting impedance in a multiple antenna system, comprising:

(a) detecting [a first operational state of] whether a first signal source connected with a first antenna via a first signal path is active or inactive;

(b) detecting [a second operational state of] whether a second signal source[, the second signal source being] connected with a second antenna via a second signal path is active or inactive, wherein the second antenna [being located near] is proximate to the first antenna; and

(c) selectively connecting a first parallel impedance circuit in parallel with the first signal path based on the [first and second operational states] active or inactive states of the first and second signal sources.

34. (Amended) The method of claim 33, further comprising:

(d) measuring external interference [near] proximate to the first antenna; and

(e) [automatically] adjusting the impedance of the first parallel impedance circuit based on the measured external interference.

35. (Amended) The method of claim 33, [wherein (b) includes detecting an operational state of a third signal source, the third signal source being connected with a third antenna via a third signal path, the third antenna being located near the first antenna and (c) includes connecting a parallel impedance circuit with the first signal path based on the first, second, and third operational states.] further comprising:

(d) detecting whether a third signal source connected with a third antenna via a third signal path is active or inactive, wherein the third antenna is proximate to the first antenna; and

(e) selectively connecting a first parallel impedance circuit in parallel with the first signal path if the first signal source is inactive and the third signal source is active to reduce electromagnetic coupling between the third and first antennas.

36. (Amended) The method of claim 33, wherein the first parallel impedance circuit comprises a plurality of selectively connectable parallel impedance circuits, and wherein (c) includes selectively attaching a selected one of [a] the plurality of parallel impedance circuits in parallel with the first signal path.

37. (Amended) The method of claim 33, further including (d) selectively connecting a second parallel impedance circuit with the second signal path if the first signal source is active and the second signal source is inactive to reduce electromagnetic coupling between the first and second antennas.

38. (Amended) The method of claim 33, wherein the first parallel impedance circuit comprises a plurality of parallel impedance circuits, and wherein (c) includes selecting a desired parallel impedance, selecting from the plurality of parallel impedance circuits one or more [a] parallel impedance circuits that most closely match the desired parallel impedance, and attaching the one or more selected parallel impedance circuits in parallel with the first signal path.